



LAWRENCE
LIVERMORE
NATIONAL
LABORATORY

Ab Initio Many-Body Calculations Of Light-Ion Reactions

C. Romero-Redondo, P. Navratil, S. Quaglioni, G.
Hupin, J. Langhammer, A. Calci, R. Roth

August 12, 2013

Nuclear Dynamics with Effective Field Theories
Bpchum, Germany
July 1, 2013 through July 3, 2013

Disclaimer

This document was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor Lawrence Livermore National Security, LLC, nor any of their employees makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or Lawrence Livermore National Security, LLC. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or Lawrence Livermore National Security, LLC, and shall not be used for advertising or product endorsement purposes.

Ab initio many-body calculations of light ion reactions

C. Romero-Redondo¹, P. Navrátil¹, S. Quaglioni², G. Hupin²,
J. Langhammer³, A. Calci³ and R. Roth³

¹TRIUMF, 4004 Wesbrook Mall, Vancouver, BC V6T 2A3, Canada

²Lawrence Livermore National Laboratory, P.O. Box 808, L-414, Livermore,
California 94551, USA

³Institut für Kernphysik, Technische Universität Darmstadt, D-64289
Darmstadt, Germany

The *ab initio* no core shell model/resonating group method (NCSM/RGM) introduced in Refs. [1, 2] is a promising technique capable of describing both structure and reactions in light nuclear systems. This approach combines a microscopic cluster technique with the use of realistic inter-nucleon interactions and a consistent microscopic description of the nucleon clusters.

The method has been introduced in detail for two-body clusters and has been shown to work efficiently in different systems [1, 2, 3, 4]. In this work we discuss recent advances of the method which include its coupling with the NCSM into a new approach called no core shell model with continuum (NCSMC) with results for ⁷He resonances [5]. We also present the first results after the inclusion of three-nucleon forces in the calculations and its effect in the nucleon-⁴He scattering phase shifts [6]. Finally, we introduce three-body cluster configurations and provide, for the first time within an *ab initio* framework, the correct asymptotic behaviour for the three-cluster wave functions. We present the results obtained for ⁶He within a ⁴He(g.s.)+n+n basis for the ground and continuum states [7].

Acknowledgments: Prepared in part by LLNL under Contract DE-AC52-07NA27344. Support from the NSERC Grant No. 401945-2011, U.S. DOE/SC/NP (Work Proposal No. SCW1158), the Deutsche Forschungsgemeinschaft through contract SFB 634, the Helmholtz International Center for FAIR and the BMBF through contract 06DA7074I is acknowledge.

References

- [1] S. Quaglioni and P. Navrátil, Phys. Rev. Lett. 101 (2008) 092501.
- [2] S. Quaglioni and P. Navrátil, Phys. Rev. C 79 (2009) 044606.
- [3] P. Navrátil and S. Quaglioni, Phys. Rev. Lett. 108 (2012) 042503.
- [4] P. Navrátil, R. Roth, and S. Quaglioni, Phys. Lett. B 704 (2011) 379.
- [5] S. Baroni, P. Navrátil, S. Quaglioni, Phys. Rev. C 87 (2013) 034326.
- [6] G. Hupin, J. Langhammer, P. Navrátil, S. Quaglioni, A. Calci, R. Roth, in preparation (2013).
- [7] S. Quaglioni, C. Romero-Redondo and P. Navrátil, in preparation (2013).